EXP-34

February 12, 1973

ACCELERATOR EXPERIMENT--Booster Aperture by Shifting Radius of Beam with rf

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A. Procedure:

At three times in the booster acceleration cycle the fraction of the beam which survives was measured as a function of radial position. The radial position was changed by tuning the $\dot{f}$ program for the low level rf system. Radial position and beam intensity were measured with the two detectors for the radial position servo. These detectors are located in long straight sections near a radial minimum of the betatron amplitude. They are separated by a betatron phase advance of 180° to make the position signal insensitive to betatron oscillations.

B. Figure 1:

Fraction of beam surviving vs. radial position at 1 msec, 8 msec, and 33 msec after injection (2 msec in booster clock time--BCP). Normalized radial position in volts has been converted to cm using calibration against c/o radial position system.

The available aperture should be determined by the radial position where the beam survival drops to zero. However, the long tails on the distributions limit the accuracy of the aperture measurements significantly. Nevertheless, the following conclusions can be drawn:

a) Approximately the full aperture of the scraper is available at 8 GeV. There is no obstacle in the beam pipe.
b) The usable aperture is significantly smaller at low energy.
c) The aperture available at injection is not much larger than the beam from the linac.

C. Figure 2:

Survival and tunes vs. radius at 1 msec.

Figure 3:

Survival and tunes vs. radius at 8 msec.

Figure 4:

Survival and tunes vs. radius at 33 msec.

Note the following:

a) In all three cases, $\nu_x = \nu_y$ near the inner aperture limit. However, the physical aperture is close enough that this may not be significant.

b) At 1 msec and 8 msec the outer effective aperture is at $\nu_x = 6.63$. At 8 GeV, the aperture extends to larger radii. However, beyond $\nu_x = 6.63$, the coherent radial betatron oscillations induced by pinging are not stable enough to permit a tune measurement, even though there is sufficient beam intensity, and vertical tunes can be measured at larger radii. The cause of this instability at $\nu_x = 6.63$ is not known.

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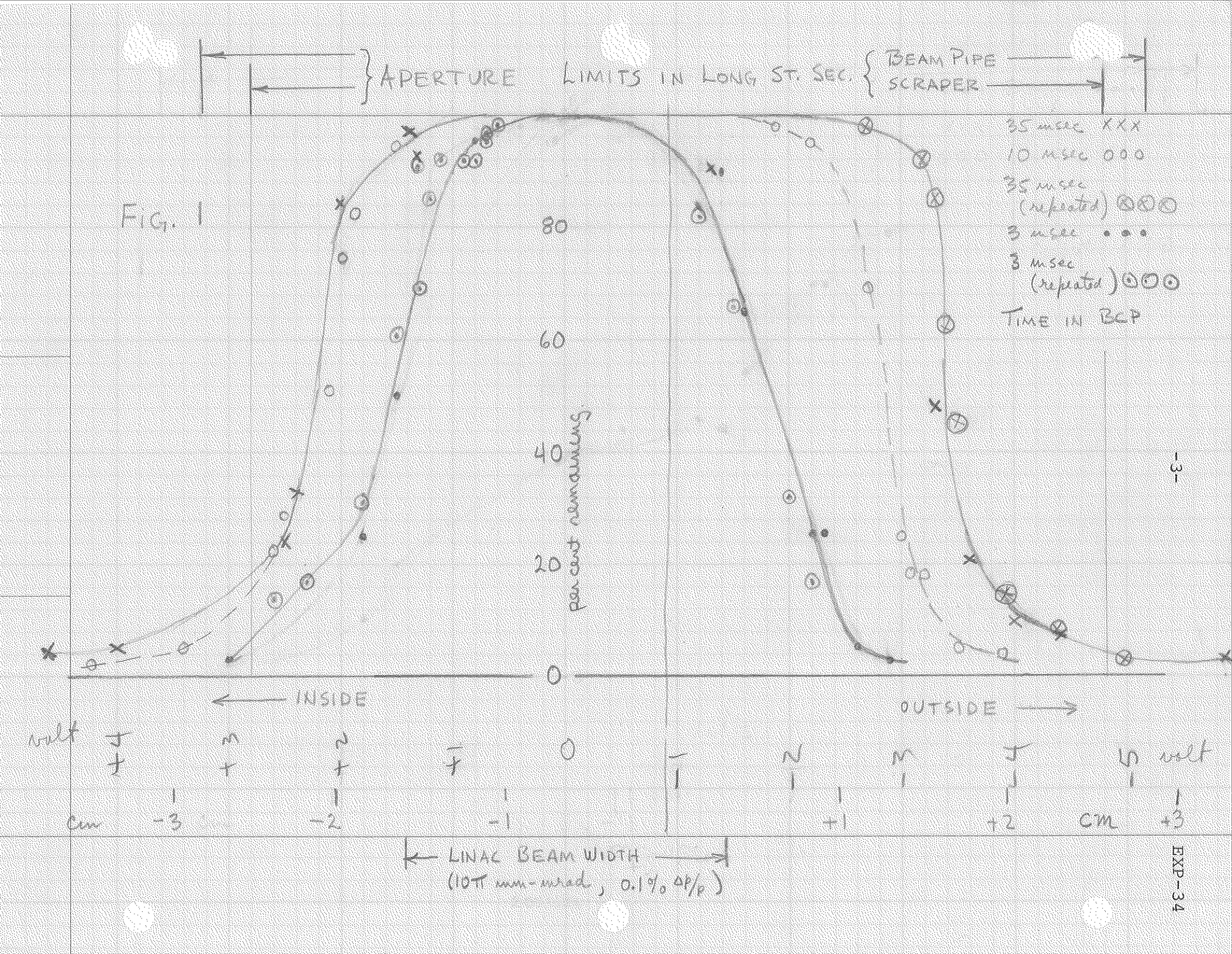
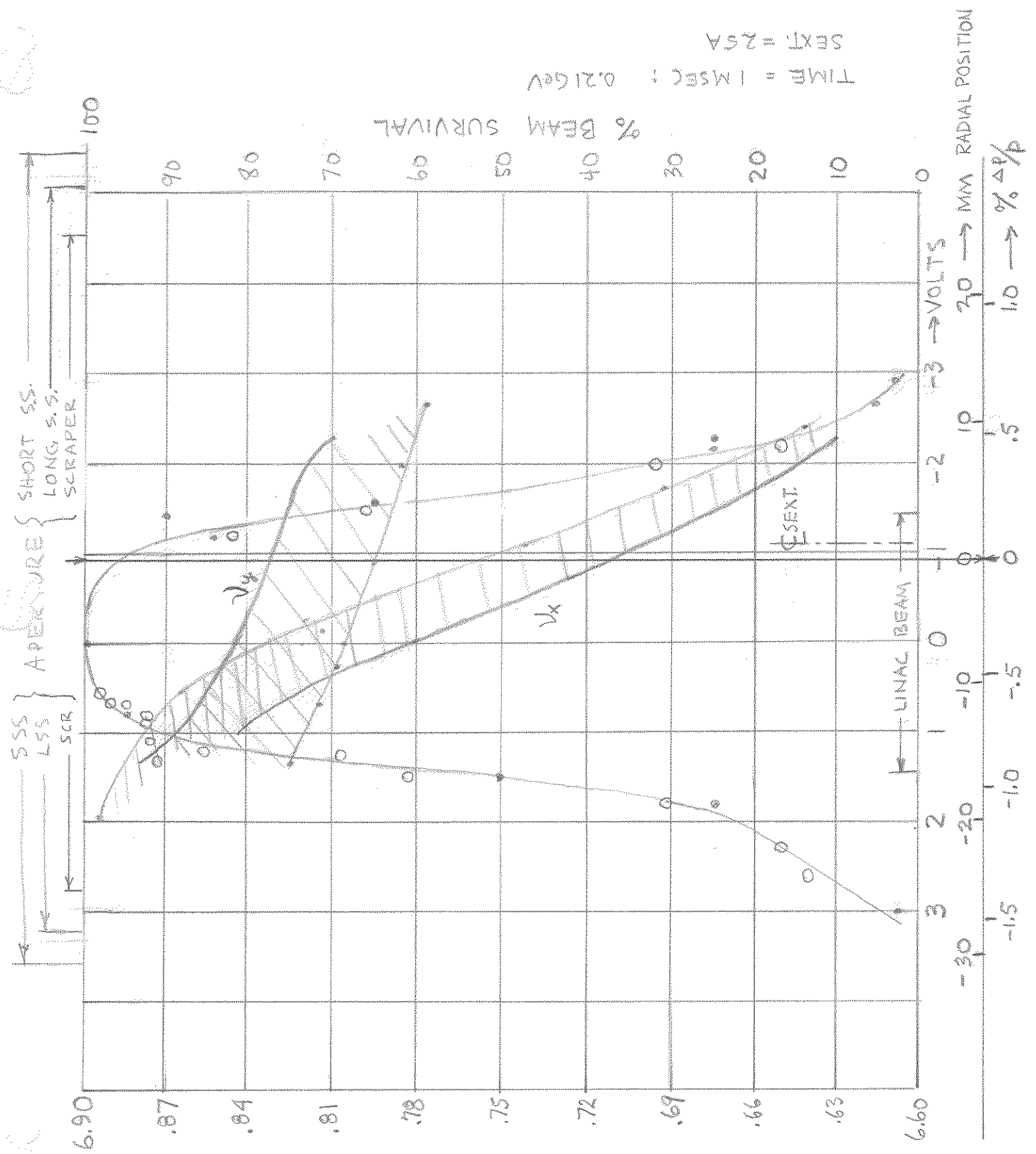
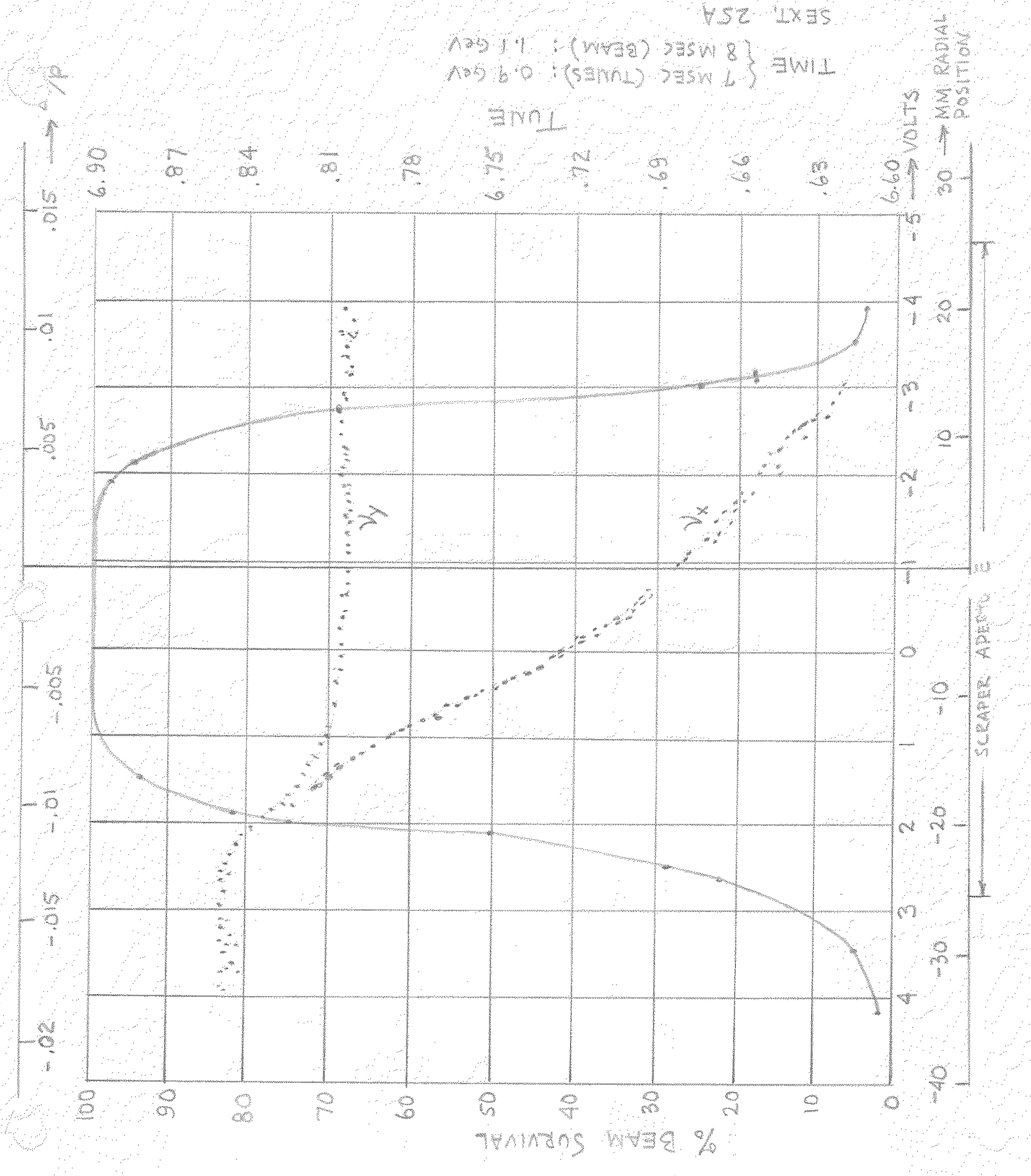

APERTURE LIMITS IN LONG ST. SEC.
BEAM PIPE
SCRAPER
35 msec XXX
10 msec ooo
35 msec (repeated) ⊗⊗⊗
3 msec • • •
3 msec (repeated) ⊙⊙⊙
TIME IN BCP
80
60
40
20
0
PARTICLES
INSIDE
OUTSIDE
mult
J
M
N
N
J
mult
cm
-3
-2
-1
+1
+2
+3
LINAC BEAM WIDTH
(10π mm-mrad, 0.1% Δp/p)

FIG. 1


% BEAM SURVIVAL
100
90
80
70
60
50
40
30
20
10
0
TIME = 1 MSEC ; 0.21 GeV
SEXT = 25A
APERTURE
SHORT S.S.
LONG S.S.
SCRAPER
SSS
LSS
SCR
VOLTS
-3
-2
-1
0
MM RADIAL POSITION
2.0
1.0
0
-1.0
-2.0
-3.0
% Δp/p
1.5
1.0
.5
-.5
-1.0
-1.5
LINAC BEAM
EXT.
6.90
6.87
6.84
6.81
6.78
6.75
6.72
6.69
6.66
6.63
6.60


SEXT. 25A
TIME { 7 MSEC (TUNES): 0.9 GeV
8 MSEC (BEAM): 1.1 GeV
TUNE
VOLTS
MM RADIAL POSITION
% BEAM SURVIVAL
SCRAPER APER

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TIME = 33 MSEC : 8 GeV
SEXT = 25 A